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**Pacific Region** | **Région du Pacifique**

# Pelagics Standing Committee reviews of: Stock assessment and management advice for the British Columbia herring stocks, 2010 assessment and 2011 forecasts, and Pacific herring biological sampling program design

# Examen par le Comité permanent sur les poissons pélagiques de l'évaluation du stock et des avis en gestion pour les stocks de harengs de la Colombie-Britannique, de l'évaluation 2010 et des prévisions 2011, et de l'élaboration du plan d'échantillonnage biologique pour le hareng du Pacifique

**September 1-2, 2010**

**Pacific Biological Station**
**Nanaimo, BC**

**Linnea Flostrand, Chairperson**

**1 et 2 Septembre, 2010**

**Station de biologie du Pacifique**
**Nanaimo, CB**

**Linnea Flostrand, présidente de la réunion**

Fisheries and Oceans Canada / Pêches et Océans Canada
Pacific Biological Station / Station biologique du Pacifique
3190 Hammond Bay Road
Nanaimo, BC / C.-B. V9T 6N7

**February 2012** | **Février 2012**

Canada

## Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

## Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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## SUMMARY

Participants from Fisheries and Oceans Canada (DFO) Science Branch and Fisheries and Aquaculture Management Branch and external participants from the Province of British Columbia Ministry of Environment, the Herring Conservation Research Society, the Haida First Nation, the Heiltsuk First Nation, Atlegay Fisheries Society, the Simon Fraser University, the University of British Columbia, Parks Canada, the Sports Fishing Advisory Board and invited biological consultants, attended a CSAS review on September 1st and 2nd to assess and develop advice on the following Research Document working papers:

- Stock Assessment and Management Advice for the British Columbia Herring Stocks, 2010 Assessment and 2011 Forecasts,
- Review of Biological Sampling Program for Pacific herring

In addition, participants assisted in the development of a Science Advisory Report titled:

- Stock Assessment Report on Pacific Herring in British Columbia in 2010

Discussions and comments on the two working papers and on the development of the Science Advisory Report are presented in these Proceedings. Both papers were accepted subject to revisions. Products of the meeting will be two CSAS Research Documents and a CSAS Science Advisory Report.

## SOMMAIRE

Les délégués de la direction des sciences et de la direction de la gestion des pêches et de l'aquaculture du ministère des Pêches et des Océans (MPO) et les participants externes du ministère de l'Environnement de la Colombie-Britannique, de la Herring Conservation Research Society, des Haïdas, des Heiltsuks, de l'Atlegay Fisheries Society, de l'université Simon Fraser, de l'université de la Colombie-Britannique, de Parcs Canada, du Conseil consultatif sur la pêche sportive, ainsi que les conseillers biologistes invités ont assisté à un examen du SCCS les 1er et 2 septembre afin d'évaluer les documents de travail suivants sur le document de recherche et de formuler des avis à ce sujet :

- Évaluation du stock et conseils sur la gestion des stocks de harengs de la Colombie-Britannique, évaluation 2010 et prévisions 2011.
- Examen du plan d'échantillonnage biologique du hareng du Pacifique.

De plus, les participants ont assisté à l'élaboration de l'avis scientifique suivant :

- Évaluation du stock de hareng du Pacifique en Colombie-Britannique en 2010

Les discussions et les remarques sur les deux documents de travail et sur l'élaboration de l'avis scientifique sont présentées dans ce compte rendu. Les deux documents ont été adoptés sous réserve de rectification. La réunion a produit deux documents de recherche et un avis scientifique du SCCS.

## INTRODUCTION

Participants of the Pelagics Standing Committee of the Centre for Science Advice Pacific met on September 1 and 2, 2010 at the Pacific Biological Station, in Nanaimo, British Columbia. External participants from industry, First Nations, academia, the provincial government, and conservation groups attended the meeting. Each day, the Committee Chair L. Flostrand, welcomed participants, reviewed the agenda and the terms of reference relevant to the review process objectives.

The Pelagics Standing Committee reviewed two Research Document working papers and one Science Advisory Report. A summary of that review process is reported herein.

## DETAILED COMMENTS FROM THE REVIEWS

### STOCK ASSESSMENT AND MANAGEMENT ADVICE FOR THE BRITISH COLUMBIA HERRING STOCKS: 2010 ASSESSMENT AND 2011 FORECASTS

*Jaclyn Cleary and Jake Schweigert*

** Paper accepted with minor revisions (assessment methodology previously accepted)**

Jaclyn Cleary presented information on the 2010 stock assessment for the B.C. herring stocks using a version of the herring catch-age model (HCAMv2), developed and approved for the 2008 assessment (Schweigert and Haist, 2008). This paper was a response to a request for science advice with the following questions:

- What is the stock status for Pacific Herring for the 2010 / 2011 fishing seasons by major and minor stock assessment area? How are herring stocks in these areas changing over time?
- What is the recommended harvest level for these areas? Are there any specific concerns that fisheries Management should be aware of, and if so, what are those concerns?

This included information on: assessment methods, results and trends and associated modelling issues. The approach involves fitting the catch-age model to the time series of commercial catch data, spawn index and proportions-at-age data within a Bayesian estimation framework. Model outputs for the time series include estimates of recruitment (3 year old fish), numbers at age, spawning stock biomass and pre-fishery forecasts of biomass, as well as estimates of natural mortality, fishing mortality and fishery selectivity by gear type. Biomass estimates represent median estimates from the marginal posterior distributions. Catch advice, presented in the form of decision tables, is based on application of the herring harvest control rule (HCR) to model forecasts of repeat spawners and posterior distributions of recruitment under assumptions of poor, average and good recruitment. For the Strait of Georgia (SOG) and west coast of Vancouver Island (WCVI) stocks, recruitment forecasts are based on results from the summer off-shore trawl survey. For the Haida Gwaii (HG; Queen Charlotte Islands), Prince Rupert District (PRD) and Central Coast (CC) stocks, recruitment forecast rules are applied based on recent stock trends (DF0 2004). For the two minor stocks, the forecast rule assumes an average recruitment. Due to a complication in the assessment model's treatment of years with missing spawn data in Area 2W, estimates of 2010 spawning stock biomass (SSB and) forecasts of abundance for 2011 are unavailable at this time.

Ron Tanasichuck presented results from the recent August WCVI trawl survey and recruitment forecasts for the WCVI and SOG assessment regions based on survey age composition data. The methodology for forecasting recruitment to these two regions was previously approved (Tanasichuk 2000, 2002) and includes predictive regressions based on the relationship between the proportions of age 2+ fish observed in the trawl survey and the proportions of age 2+ fish estimated by the current year's assessment model for the subsequent pre-fishery or pre-spawning season. The recruitment forecast for the 2011 pre-fishery/pre-spawning season was "good" for the SOG and "average" for the WCVI.

## COMMITTEE DISCUSSION

During the author's presentation, figures representing spatial distributions of biosamples and tables summarizing recent spawn length and width observations were shown. Both these sets of summary information were thought to be valuable and it was suggested that they be included in the final research document.

Fishing cutoffs: The fishing thresholds (also known as "cutoffs") used in the management framework were discussed. If the current cutoff levels were extended back in time, many fisheries would not have been allowed (i.e., the biomass estimates would have been below the cutoff values). Retrospective estimates of biomass have changed over time (due to updating datasets and assessment model modifications) and changes to the cutoffs are not shown in the figures. This issue was identified at the June 2010 workshop and in the recommendations from that workshop. The idea of changing the cutoffs each year was not favoured by some participants, but someone suggested it could be examined using computer simulations. Alternatively, it was suggested that with long time series, an examination of biomass minima from which stocks have recovered may prove to be useful in calculating reference points. It was also suggested that the Northeast Pacific ocean is in different state of productivity than it was in past decades and choosing a limit reference value from a year of historically low biomass might not be representative of the current state of ocean productivity. It was pointed out however, that the currently-used $B_0$ (ie. 1996) has the same issue. Future work should examine alternative methods for calculating cutoffs, in the context of management strategy evaluation (MSE). It was also suggested that future work consider what is done for other herring populations and for other species.

Variation in egg layers: It was suggested that the spawn survey data indicate a systematic change in the estimates of egg layers over time. Science staff and HCRS consultants have been discussing this topic within and outside of CSAP meetings and future work on this question is being planned. It was stated that herring egg layers may have biological consistency over time and if so, there are questions of whether an observed decrease in the number of egg layers over time is real or an artefact of implementation of the dive survey protocols.

Inclusion of spawn-on-kelp fish mortality in the assessment model: There were inquiries on how the SOK fishery is sampled and whether information is being collected for inclusion into the assessment model. Currently, the assessment model does not assign any mortality from SOK fisheries, thus, the model may be accounting for SOK induced mortality by adjusting (increasing) natural mortality. Past stock assessments have allocated rough estimates of SOK-induced mortality. Both modelling approaches are subject to bias that would affect model parameters and potentially reference points. This is considered by some to be a relatively small fishery, thus they also believe that the lack of SOK data may have a relatively small impact on assessment estimates, however, others believe this assumption is unwarranted. Either way, the committee

agrees that future modelling work should explore effects from varying SOK mortality estimates, ideally in association with acquiring accurate SOK fishery data.

Parameterization of the model: M and q: The unusually high increases in estimates of natural mortality (M) over time were discussed. Discussion ensued that natural mortality may have increased considerably over time because of predation from increasing abundance of marine mammals, such as cetaceans (humpbacks and grey whales), sea otters (feeding on spawn and spawn-on-kelp) and pinnipeds. It was also mentioned that there may be inter-species competition between sardines and herring. It was recommended that this type of information, especially where supported by published information, be included in the Ecosystem Considerations section of the SAR and possibly future herring stock assessment research documents. There was debate over whether this information should be included as part of an assessment document, largely due to the information gaps and lack of citable research.

It was suggested that the document needs more explanation on the role of q (proportionality coefficient between the spawn survey estimates and model spawning biomass estimates) to assist readers in understanding modelling approaches. There was interest in exploring the issue of M being confounded with "q" especially since the HCAMv2 assumes q =1. This topic has been discussed at past CSAP herring assessment reviews and was also a topic of discussion at an HCRS workshop held in June, 2010. The committee agrees that this remains a topic requiring further exploration.

Spawn index and estimates of SSB: Residual patterns for the modelled time series of SSB fitted to the spawn index were discussed (Figure 12 of draft Res Doc). Based on the run of negative residuals for the SOG, it was suggested that the HCAMv2 likely underestimates SOG herring biomass in recent years because: 1) q is assumed to be 1 and spawn is likely missed due to predation and/or survey constraints, and, 2) age composition data may be unrepresentative. The committee believes that further investigation into the cause of these patterns is warranted.

Alternative recruitment forecasting methods: Committee members discussed the possibility of including alternative recruitment forecasting information in the assessment process. There are past CSAS and primary publications that include estimates of herring recruits based on regressions using juvenile data. The model estimates age-3 spawners (i.e. using proportions of age -2 fish observed in samples in a previous season) but does not consider data from juvenile seine surveys or juveniles observed in the offshore summer trawl survey. Future work should investigate and compare different methods of recruitment forecasting. This recommendation has been captured in previous proceedings.

The 2005 and 2007 September SOG juvenile herring seine surveys had very low (0+) juvenile herring catches which accurately predicted low 2008 and 2010 age-3 recruitment. The 2006 juvenile survey observed relatively high catches, which predicted good age-3 recruitment in 2009. What were the biological and ecological differences in the 2006 spawning and/or rearing seasons relative to the two adjacent years? This highlights the many information gaps related to different causes of herring mortality. Someone mentioned that diseased herring in Puget Sound and other areas of Washington have corresponded to poor brood years.

## CONCLUSIONS

- The Committee endorsed the application of the current recruitment forecasting system (initiated in 2004) for the 2011 season, whereby forecasts for the SOG and WCVI are based on the summer trawl survey observations and forecasts for the three other major stocks are based on approved decision rules. Application of the forecast rules always assigns "average" recruitment to minor areas.

- Application of the recruitment forecasting rules estimates recruitment as "poor" for the Haida Gwaii and Central Coast stocks, "average" for the Prince Rupert, west coast of Vancouver Island and the two minor stocks (Area 2W, Area 27), and "good" for the Strait of Georgia.

- The Committee endorsed the 2011 forecasts of pre-fishery mature stock biomass for the major stock areas and for Area 27. These forecasts are: Haida Gwaii - 4,140 tonnes; Prince Rupert District - 19,172 tonnes; Central Coast - 6,374 tonnes; Strait of Georgia - 68,886 tonnes, west coast of Vancouver Island - 8,778 tonnes and Area 27 - 935 tonnes.

- The 2011 forecasts of abundance for the HG, CC and WCVI assessment regions are below commercial fishing cutoff levels.

- The 2011 forecasts of abundance for the PRD and SOG assessment regions are above fishing cutoff levels and the Committee endorsed the harvest options from these regions as described by existing harvest rules.

- The 2011 forecasts of abundance for Area 27 and the application of the 10% harvest rate rule were endorsed by the Committee.

- A 2011 forecast of abundance for Area 2W was not provided. It was concluded that more work was needed to explore how Area 2W can be modelled and assessed given there are years lacking spawn observations (affecting how abundance is calibrated). The authors will work with managers to determine a precautionary approach for this area for the 2011 season.

## RECOMMENDATIONS

- Three editorial revisions to the research document were specifically requested by Committee members. These were that authors include: 1) figures representing 2010 spatial distributions of biological sample coverage, 2) a table summarizing spawn length and width measurements from spawn surveys of recent years, and 3) more explanation on the role of q (proportionality coefficient between a spawn survey estimate and a spawning biomass estimate) to assist readers in understanding modelling approaches.
- Future work should be done to re-evaluate fishing threshold (cutoff) levels in consideration of more recent ecological conditions of the BC coast. It was also suggested that fishing thresholds applied to other herring populations and other species with similar life histories be reviewed.
- Future work should explore and evaluate modelling effects from varying spawn-on-kelp mortality, ideally in association with acquiring accurate SOK fishery data.
- Future work should examine key model parameters (M, q, etc) to evaluate biases.
- Future work should evaluate alternate methods for forecasting recruitment.

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## REVIEW OF THE BIOLOGICAL SAMPLING PROGRAM FOR BRITISH COLUMBIA HERRING

*Jaclyn Cleary and Ashleen Benson*

** Paper accepted with major revisions **

Results from a review of the biological sampling program for BC herring were presented by the authors. This paper was a response to a request for science advice with an overarching scope based on the following questions:

- What is the optimal spatial and temporal sampling coverage required to adequately characterize fish size and age structure of Pacific Herring stocks in the major assessment areas?
- Do the existing data indicate whether the precision of estimates of biological characteristics has changed over time?
- Are there differences in characteristics that might suggest separate biological stocks in some areas, e.g., Central Coast (CC) subareas 6, 7, and 8?

The intention of the paper was to describe key aspects of the herring datasets as a basis for additional exploratory work addressing data quality questions associated with sampling coverage and sampling methods. The authors focussed their analysis on characterizing the spatial and temporal sampling coverage of the bio-sampling program from 1980-2009, while considering the following:

- How has the bio-sampling program changed over time?
- Are we representatively sampling a) the catch and b) the population?
- What are the current assumptions made about the biological data?
- What uncertainties should we be considering with respect to the assessment?

**Formal reviews**

Two reviewers presented their comments on the paper. Reviewer 1 viewed this paper as a good first step to exploring what data are available and what is known about the data, including potential sources of bias, error, and gaps. In addition to written comments provided, Reviewer 1 indicated some terms could be clarified (e.g., sample, sample size, bucket, opening vs. fishery, etc.). Reviewer 1 also pointed out that test and commercial catch samples, currently combined, do not provide fishery-independent data. If the herring assessment model does not have a different selectivity for each of the data sets, then effectively the data are combined. To address their individual and collective utility, the goals of the data collection for use in stock assessment should be considered. In addition, this reviewer pointed out that test fishery data may represent different things over the season, especially since in-season sampling is used to assist management where fisheries occur. Because of this, test fishery data may represent mature fish available early in the season (considered a proxy for spawning population) and then represent components of the commercial catch later in the season. It was also noted that methods used to select test fishery sites/locations, by targeting larger aggregations more frequently, may result in non random sampling allocation. The goal should be to achieve a randomized sampling procedure and a management strategy evaluation (MSE) could address questions related to uncertainty in sampling methods, such as how many samples are needed and how these are allocated in space and time. The reviewer thought the document should have more emphasis on the need for an MSE.

Reviewer 1 found the authors' description of the spawning window and the 75$^{th}$ percentile of observed spawning biomass helpful. However, the reviewer also pointed out the need for a description of spawn observation protocol and the associated error. Reviewer 1 sought clarification on several points: 1) whether the goal was to sample the spawning biomass or the population of fish, 2) if there was a peak in weight at age at the 75$^{th}$ percentile in samples (which may provide useful information), 3) whether there are differences in the size, age, and weight at age in samples in areas where there are only biological samples and no spawn versus areas where there are biological samples and spawn, and 4) if the way in which test fishery samples are collected from the seine net is representative of what is caught in the seine net.

Reviewer 2 also provided written comments and agreed with Reviewer 1 regarding the need for the document to clarify relevant methodology and terms (including "representativeness" and "coverage", which he emphasized are not always correlates). Reviewer 2 also asked for clarification on several points: 1) the document focuses on how representative the samples are of "the population" not of "the catch", however, is catch information the only type of data needed for the model?; 2) there may be over-representation of late-spawners if they are in the area for an extended sampling period; 3) clarification is needed regarding how representative the spawn survey is in each area to relate to samples; 4) explanation needed why spawn survey data linked to biosample data (i.e. Figure 6); 5) the document only addresses the combined sample sources and how representative they are of the population and more discussion is needed regarding how representative the test and catch sampling are for each of their objectives.

## COMMITTEE DISCUSSION

Scope of document: The focus of the paper was discussed in terms of the request for science advice. The paper aimed to demonstrate and describe aspects of the catch and test fishing data sets and their role in terms of past and current use in stock assessment and management advice. Some committee members thought the scope of the request was too broad and it was suggested that authors provide additional background describing how their explorations are linked to the request for science advice. It was also suggested that the document should provide further explanation on how and why catch and test fishing sampling data have been collected and used as input into stock assessment models and how uncertainties with data representativeness relate to model uncertainty. Committee members indicated that the document somewhat addresses the question of whether we are representatively sampling the population over space and time. But the answer is that "we do not know" and there is debate over the definition of "the population". Does the population include all sexually mature fish that occur within the boundaries of the major and minor stock boundaries? Or does the population include aggregations of mature fish that are catchable by seine and/or gillnet gear over limited temporal and spatial conditions? Should we continue to assume these are equivalent definitions without testing aspects of the assumptions? There was debate regarding whether the document should provide a description of the assessment model and how the data are used in the model. The general conclusion was that this is beyond the scope of the document but that the application and evaluation of the datasets as being representative input data (in general terms) should be emphasized. One reviewer pointed out that although the paper addressed aspects of spatial and temporal coverage, there are other aspects of representativeness that were not addressed and this should be stated in the research document. For example, samples of herring catch may have extensive temporal coverage (many samples over a long period of time) but that the representation may be poor if the samples are not weighted by the distribution of the catch effort in time and space. Similar tendencies would occur when sampling "the population".

Catch sampling program: There was some debate over the purpose of the catch sampling program and Committee members discussed the need for consideration of whether the catch sampling program and data are meeting the requirements of the catch-at-age model. It was suggested that the paper should provide additional background describing the catch data and that further explanation was needed to emphasize the utility (past and future) of the dataset as it pertains to any assessment model and to possible MSE steps. Several assumptions and limitations of the catch data were discussed, including : the resolution of spatial representation (i.e. Herring Location) is often vague or lumped in records (and not captured in metadata), and weight-at-age data for 1980 and 1981 are inaccurate because of size and age mis-matches during the time of data processing. It was identified that there were no analyses in the research document to address whether the catch sampling program truly represents the catch. Occasionally, samples come from pool fishery catches that have a mix from more than 1 Herring Section and when this happens, they are labelled by where the majority of fish were caught. There was discussion regarding whether locations are consistently named in the database and whether locations can straddle multiple sections. The database is currently set up so that a location has to be within a section. It was pointed out that in Figure 7 the y-axis values are not consistent over time, due to inconsistent location naming conventions. A recommendation was made that the y-axis of Figure 7 should more accurately reflect the spatial resolution of the data.

It was also suggested that future work should develop a summary reference table, which would include: all fisheries; dates of fisheries; if each fishery was sampled or not; the extent to which it was sampled; descriptions of any changes in sampling methodology for an area and/or season; if

and how samples were lumped across vessels; and other qualitative and quantitative notes on the time series and on historic catch sampling. It was also suggested that a workshop may be warranted to review this type of information to evaluate the utility of the bio-sampling data as a means of sampling the catch and the population.

Test fishery program: There was some discussion over the purpose and effectiveness of the test fishing sampling program, since this program has multiple purposes (in-season observations for management and biosamples for stock assessment). It was pointed out that test fishing samples are more concentrated in time as the fishery approaches because of management interests and greater fish availability. It was suggested that the research document should describe how test fishing has sampled spawning aggregations, with each sample having equal statistical weight as input data into assessment models.

The authors requested confirmation on test fishery data collection methods. Instructions given to individual test fishery vessels (not the entire sampling fleet) include: 3-4 samples/week from primary aggregations and 1-2 samples/week from secondary aggregations. It was pointed out that these instructions are only guidelines and may vary depending on a number of variables (manager's concern, weather, etc.). In addition, the definitions of "primary" and "secondary" aggregations were discussed. In general, primary sampling sites are areas where large aggregations are expected to occur; whereas, secondary aggregations are areas where it is less likely for herring to be found. The guidelines should at some point be updated but it was said that although field logistics will prevail, accessible metadata is important.

Comparing catch sampling and test fishing programs: There was discussion regarding the representativeness of test fishery samples compared to catch samples and also regarding methods used to collect the samples. In particular, members discussed how the test fishery samples are collected differently (with the use of a hoop net to subsample a seine catch) than commercial catch samples, potentially resulting in size and/or sex-biased samples if fish stratify themselves by size in the net. This has been examined in the past, but it could be re-examined by looking at the sex ratio of test samples; however, some members caution that commercial catches can also have a skewed sex ratio. In addition, the test fishery initially samples fish in a broad geographic area, but as the season progresses and the timing of the fishery approaches, samples are collected from fish that are going to be commercially fished. One concern that was voiced is that the test fishery samples taken closer to the fishery may be more representative of the catch than the population. Samples of commercial catch are also not necessarily representative of the population because they focus on a certain segment of the population. It was argued that all sampling (commercial catch and test fishery) is selective; and that the herring catch-at-age model does incorporate selectivity. With regard to spatial coverage of samples, the recent reduction of sampling effort is also a result of having three assessment areas closed to fishing, although, some samples are still being collected by the test fishery program. Someone asked if and how the uncertainty in age data is captured by the assessment model and recorded in the database. The answer to this was that the model does not account for this uncertainty and the database records only the most likely age.

Presence only data: Data collection is currently presence-only; therefore, it is unknown if trends in the spatial distribution of spawn records and/or biosample acquisitions are due to changes in sampling distribution or changes in spawning behaviour. In Figure 6, it was recommended to include a symbol for when no roe fishery took place as opposed to a blank indicating no sample. Changes in management and test fishing resources have affected the number and location of samples. Committee members discussed the possibility of capturing presence/absence data (that

is not included in the database) from historical records of test fishery sampling, spawn deposition, vessel log book information, and spawn flight surveys. It was suggested that future work should be done to try to compile this information from field notes (likely a huge task) and someone mentioned that this process could be considered by a working group.

RECOMMENDATIONS FOR FUTURE WORK: SEVERAL IDEAS RELATED TO FUTURE ANALYSES OR IMPROVING DATA QUALITY WERE SUGGESTED DURING THE MEETING AND ARE LISTED BELOW FOR REFERENCE PURPOSES. ITEMS ARE NOT LISTED IN ANY PARTICULAR ORDER AS THE COMMITTEE DID NOT COLLECTIVELY EVALUATE THESE SUGGESTIONS:

1. Explore the possibility (potentially in a workshop) of adequately capturing presence/absence data since absence data is not included in the database. Records could be updated from historical information of spawn deposition surveys, vessel logbooks, spawn flight surveys and other sampling efforts.

2. Investigate assumptions behind linking biological sample data and spawning events to address what value biosamples have when spawning events are many days to weeks apart in time or are separated by 1 of more herring sections in space. Examine if there are differences in the size, age, and weight at age in samples between areas where there are only biological samples and no spawn versus areas where there are biological samples and spawn.

3. Explore the possibility of including gonadosomatic index (GSI) data in conjunction with temporal sampling coverage information presented in Figure 6.

4. Explore the test fishery biological data to see how it changes over time within the spawning window: One example was to examine if there is a peak in weight at age at the 75$^{th}$ percentile of the cumulative spawning biomass or at other percentiles. Another example was to explore data and run a time series model within season to see if there are different biological patterns (repeated measures model). In addition, the authors could test if fish are more similar to each other within a section than across sections.

5. Test the assumption that bucket/hoop net sampling in the test fishery is representative of seine catch.

6. Update records in the herring stock assessment database to improve spatial resolution on commercial and test fishing biological sample sources.

7. Develop a summary reference table, which would include information on: all fisheries; dates of fisheries; if each fishery was sampled or not; the extent to which it was sampled; descriptions of any changes in sampling methodology for an area and/or season; if and how samples lumped across vessels; and other qualitative and quantitative notes on the time series and on historic catch sampling. It was also suggested that a workshop may be warranted to review this type of information to evaluate the utility of the bio-sampling data as a means of sampling the catch and the population.

## CONCLUSIONS

The Committee agreed that the paper offers valuable exploratory information on data trends from the commercial catch sampling and test fishing programs but that major revisions are required prior to acceptance. The Chair with the aid of identified participants will review changes to a revised version of the document to ensure that "required revisions" are addressed.

### REQUIRED REVISIONS

1. Clarify scope of the document and relevance to its objectives and the request for science advice. The discussion in the document should address objectives 1-3 that were outlined by authors but objective 4 of the draft is not addressed nor supported at this stage and should be removed or reworded.

2. Clarify and/or redefine the spatial resolution of the y-axis in Figures 7 and 8 because the resolution of the data is poor and inconsistent at the scale of "Herring Locations".

3. Gillnet and seine catches should not be combined for age and weight distributions on Figures 9 and 10 because gillnets are designed to be size selective and seine nets are not.

4. Fish length rather than weight should be used for Figures 9 and 10 because of the high variability in weight between pre- and post-spawning periods (i.e. due to gonad loss).

### MINOR REVISIONS TO IMPROVE DOCUMENT CLARITY

1. Clarify terms, such as sample, sample size, bucket, opening versus fishery, representativeness, coverage. Acknowledge that spatial and temporal coverage are not the only aspects of sample representativeness.
2. Clarify definition of "representativeness" with respect to test and catch fishing programs. The document only addresses the combined sample and how representative it is of the population and more discussion is needed regarding how representative the test and catch sampling are for each of their objectives.
3. Clarify the purpose of the catch sampling program.
4. Provide a clearer summary regarding the purposes of the test fishery program (assessment and management), methods, assumptions (samples are not weighted, despite sampling a dynamic spawning population), and changes in sample coverage through time.
5. Clarify and discuss the role of spawn survey program, what the role of the spawn survey dates and cumulative spawn biomass estimates aim to represent and what relevance these data have in terms of relating spawning window of the cumulative spawning biomass percentiles (0, 75% and 100%) with biosample data collection dates.
6. There was discussion regarding the advantages and disadvantages of linking this to an MSE. The authors might consider adding a statement about how an MSE may be able to address issues pertaining to the quality and quantity of sampling data.
7. The document includes references to genetic variation, but there was no discussion of this in the document. Authors could expand on this in their discussion.
8. Outline how the data summarized in this document can be used in the future.

## APPENDIX 1. AGENDA

**AGENDA**
**CSAP PELAGICS STANDING COMMITTEE MEETING Sept 1-2, 2010**
Pacific Biological Station, Seminar Room, Nanaimo, BC

**Wednesday, Sept 1, 2010**

| | |
|---|---|
| 9:00 – | Introductions and Opening Remarks. |
| 9:30-12:00 | Presentation and points of clarification on:<br>"Review of Biological Sampling Program for Pacific herring"<br>-by Jaclyn Cleary and Ashleen Benson<br><br>Presentation of formal reviews.<br><br>Open review discussion on research document findings |
| 12:00-1:00 | Lunch |
| 1:00- 2:30 | Continue review of working paper |
| 2:45-4:00 | Develop and clarify conclusions and recommendations of the review. |

**Thursday, Sept 2, 2010**

| | |
|---|---|
| 9:00 | Introductions and Opening Remarks. |
| 9:30-12:00 | Presentations and points of clarification on:<br>"Stock Assessment and Management Advice for the British Columbia Herring Fishery, 2010 Assessment and 2011 Forecasts",<br>-by Jaclyn Cleary and Jake Schweigert<br><br>Brief summary of summer trawl survey findings and recruitment forecasts for WCVI and SOG -by Jennifer Boldt or Ron Tanasichuk<br><br>Begin review discussion on research document findings |
| 12:00-1:00 | Lunch |
| 1:00-2:30 | Finalize review of working paper |
| 2:45-4:00 | Review Science Advisory Report (SAR) and finalize conclusions and recommendations related to the proceedings and SAR. |

Meeting adjourned 4:00pm Thursday Sept 2nd.

## APPENDIX 2. LIST OF ATTENDEES

**DFO** (Last Name in alphabetic order)

| Last Name | First Name | Affiliation | Sept 1 | Sept 2 |
|---|---|---|---|---|
| Boldt | Jennifer | DFO, Science | X | X |
| Brown | Laura | DFO, Science | | X |
| Cleary | Jaclyn | DFO, Science | X | X |
| Daniel | Kristen | DFO, Science | X | X |
| Detering | Jackie | DFO, Science | X | X |
| Einarson | David | DFO, FAM | X | X |
| Flostrand | Linnea | DFO, Science | X | X |
| Fort | Charles | DFO, Science | X | X |
| Francis | Kelly | DFO, | X | X |
| Houtman | Robert | DFO, Science | X | |
| Joyce | Marilyn | DFO, Science | X | X |
| Leslie | Karen | DFO, FAM | X | X |
| MacConnachie | Sean | DFO, Science | X | X |
| McCarter | Bruce | DFO, Science | X | X |
| Mijacika | Lisa | DFO, FAM | X | X |
| Nichol | Linda | DFO, Science | X | X |
| Palfrey | Terry | DFO, Science | X | |
| Schweigert | Jake | DFO, Science | X | X |
| Spence | Brenda | DFO, FAM | X | X |
| Tanasichuck | Ron | DFO, Science | X | X |
| Thompson | Matthew | DFO, Science | X | X |
| Webb | Randy | DFO, FAM | X | X |

**Non-DFO** (Last name in alphabetic order)

| Last Name | First Name | Affiliation | Sept 1 | Sept 2 |
|---|---|---|---|---|
| Ashcroft | Chuck | SFAB | | X |
| Benson | Ashleen | SFU, REM | | X |
| Chalmers | Dennis | BC Ministry of Fisheries | X | |
| Cooper | Andy | SFU, REM | X | |
| Gladstone | Keith | Heltsiuk Tribal Council / Gladstone Reconciliation | X | |
| Haist | Vivian | Consultant (HCRS) | X | |
| Hamer | Lorena | HCRS | X | X |
| Hay | Doug | DFO Scientist Emeritus | X | X |
| Hrabok | Christa | A-Tlegay Fisheries Society | X | X |
| Irving | Nicholas | Parks Canada | X | X |
| Jones | Russ | Council of Haida Nation | X | X |
| Lovy | Jan | DFO Post Doc | | X |
| Martell | Steve | UBC Fisheries | X | X |
| Moody | Reg | Heiltsuk Tribal Council & Gladstone Reconciliation | X | |
| Newman | Earl | Heltsiuk Tribal Council & Gladstone Reconciliation | X | X |
| Robinson | Cliff | Parks Canada | X | |
| Safarik | Ed | HCRS | X | X |
| Starr | Paul | Consultant (HCRS) | X | X |

Andrew Cooper and Robert Houtman graciously prepared formal reviews for the paper titled "Review of Biological Sampling Program for Pacific herring".

## APPENDIX 3. TERMS OF REFERENCE.

**Terms of Reference: Regional Advisory Meeting, *Revised August 30th***

**Center for Science Advice Pacific (CSAP)**
***(Formerly named Pacific Scientific Advice Review Committee -PSARC)***
**Pelagics Standing Committee**

**September 1 -3, 2010**
**Seminar Room, Pacific Biological Station. Nanaimo, BC**

**Chairperson: Linnea Flostrand**

**Background**
The *CSAP Pelagics Standing Committee*, along with additional invited participants as required, meets annually to review the stock status of Pacific herring populations and other related herring research and assessments. These reviews are based on specific questions outlined in formal *Requests for Science Information and Advice*. The 2010 CSAP Pelagic Standing Committee meeting will review two research documents pertaining to Pacific herring stocks in British Columbia waters. Additional review meetings may be held as required.

The first research document investigates technical aspects of herring sampling coverage for stock assessment purposes. There has been ongoing interest to explore the cost-benefits and tradeoffs of varying spatial and temporal sampling coverage versus the effects on the precision of parameter estimates. Conclusions and recommendations from several past Pelagics PSARC (CSAP) Subcommittee review meetings have identified this need. Furthermore, these types of evaluations are required in order recognize whether datasets in the time series can be used to distinguish different biological characteristics between regional stock groupings. This paper is intended to be the initial phase of a multi-stage plan to address sampling coverage and data quality questions. The intent of the working paper is to describe the 1980-present herring sampling protocols and time series datasets; to identify differences in age-composition under different sampling window time frames; to consider effective sample size, and to describe future recommended steps.

The second research document outlines the methods and results associated with applying updated datasets to a previously reviewed and accepted stock assessment model "Pacific herring assessment model version 2" (HCAMv2) in order to characterize trends and forecasts in abundance and stock structure (e.g. age and size composition). The document may also describe outstanding issues related to stock assessment methods, information gaps, and ecosystem considerations. For many years, resulting trends and forecasts from updated herring stock assessments have been applied into a precautionary decision making framework for the management of herring fisheries.

**Objectives**
Peer review the two working papers related to the assessment and management of Pacific Herring (titles and authors listed below), with regards to questions outlined in formal *Requests for Science Advice and Information (bulleted below)*:

Review of the Biological Sampling Program for British Columbia Herring -by Jaclyn Cleary and Ashleen Benson

- What is the optimal spatial and temporal sampling coverage required to adequately characterize fish size and age structure of Pacific Herring stocks in the major assessment areas?
- Do the existing data indicate whether the precision of estimates of biological characteristics has changed over time?
- Are there differences in characteristics that might suggest separate biological stocks in some areas, e.g., Central Coast (CC) subareas 6, 7, and 8?

Stock Assessment and Management Advice for the British Columbia Herring Stocks: 2010 Assessment and 2011 Forecasts - by Jaclyn Cleary and Jake Schweigert.

- What is the stock status for Pacific Herring for the 2010 / 2011 fishing season by major and minor stock assessment area? How are herring stocks in these areas changing over time?
- What is the recommended harvest level for these areas?
- Are there any specific concerns that fisheries Management should be aware of, and if so , what are those concerns?

**Responsibilities of CSAP Meeting Participants**

- Prior to the meeting, review distributed documents.
- Ensure oral and written contributions comply with standards of objectivity and impartiality.
- Ensure information presented in documents and at meetings is treated as confidential until formally published.

**Products**

- CSAS Proceedings summarizing the subcommittee discussions on the reviews of the two papers.
- CSAS publication of approved research documents.
- CSAS Science Advisory Report, summarizing findings, science advice and key conclusions of review process associated with the research document "*Stock Assessment and Management Advice for the British Columbia Herring Stocks, 2010 Assessment and 2011 Forecasts*" review.

**Participants**

Participants (approx. 25) will include internal DFO representatives and invites from academia, First Nations, NGO's and industry.

## APPENDIX 4: WORKING PAPER ABSTRACTS

### REVIEW OF THE BIOLOGICAL SAMPLING PROGRAM FOR BRITISH COLUMBIA HERRING

*Jaclyn Cleary and Ashleen Benson*

Reductions in funding and restrictions on the number of age samples processed each year have resulted in declines in both the spatial coverage of the test fishery program and the total number of herring age samples collected and processed each year. However, both the bio-sampling and the spawn survey programs sample "presence only" data making it difficult to determine whether declines are strictly representative of changes in sampling or whether this is a reflection of changes in spawning behaviour.

We found there to be no persistent or systematic change in the timing of the spawning window in any of the major stock areas from 1980-2009, and that all stocks show consistent timing in the accumulation of the majority (75%) of herring spawn. Given the spatial and temporal coverage of the bio-sampling program, the data support the provision of science advice at the level of major stock area. However, given inconsistencies in the overlap of the spawn survey and bio-sampling programs at a smaller spatial scale, as well as uncertainty about herring movement patterns prior to spawning, we do not recommend using these data for the purposes of sub-stock ID.

We defined late spawners as those comprising the latter 25% of the spawning biomass, and for these fish there is little to no biological information collected. Previous work indicates that these late spawning fish may be new recruits to the spawning population. Poor representation of these fish in the biological data may skew the age composition towards older cohorts, and potentially impact estimates of recruitment.

The initial Request for Science advice focused on questions related to "precision of estimates" and "optimal sampling allocation". However, the bio-sampling program is only one component of the herring management system, and can not be meaningfully evaluated apart from the stock assessment and harvest control rule. In a management context, the quality of this program will be indicated by its contribution to the achievement of management objectives. We propose future work in the form of a management procedure (strategy) evaluation, redirecting the research questions toward "how much and what type of data should we collect to maximize achievement of management objectives".

### STOCK ASSESSMENT AND MANAGEMENT ADVICE FOR THE BRITISH COLUMBIA HERRING FISHERY, 2010 ASSESSMENT AND 2011 FORECASTS

*Jaclyn Cleary and Jake Schweigert*

Herring stock abundance in British Columbia (B.C.) waters are assessed for 2010 and forecasts were made for 2011 using the herring catch-age model (HCAMv2), developed for the 2008 assessment (and revised in 2009). B.C. herring stocks are managed as five major and two minor stock areas. Accordingly, catch and survey information is collected independently for each of these seven areas and science advice is provided on the same scale. All available biological data on spawn deposition and age and size composition of the spawning stocks, as well as commercial harvest data, were used to determine current abundance levels. Herring abundance has remained relatively stable over the past few years, with no substantial changes in 2010. The total estimated pre-fishery biomass for the major assessment regions for 2010 is 99,226 metric tonnes (t), broken down as follows: Haida Gwaii (QCI 2E) – 6,046 t, Prince Rupert District (PRD) – 19,039 t, Central Coast (CC) – 7,974 t, Strait of Georgia (SOG) – 48,262 t, and west coast of Vancouver Island (WCVI) – 3,335 t . Pre-fishery biomass estimates for 2009 and 2008 are 103,470 t and 95,076 t, respectively. Recruitment of the 2007 year class in 2010

was poor for HG, CC, SOG and WCVI, while recruitment in PRD was average. Pre-fishery biomass in 2010 for the minor stock of Area 27 was 998 t with poor recruitment. Biomass estimates for Area 2W cannot be provided to represent the 2010 adult mature stock nor for a 2011 forecast. This is because the model cannot assess this area given there are years lacking spawn observations, which affects how abundance is calibrated. Stock projections for 2011 indicate reduced abundance and poor recruitment in three major stock areas. Implementation of the herring harvest control rule (HCR) advises the following stocks will not support a commercial harvest: HG, WCVI, and CC. Spawning stock biomass for two of the five major stock areas is forecast to be above the biomass cutoff level for 2011. Based on a 20% harvest rate and application of the recruitment forecasting rules, the estimated maximum available harvest of B.C. herring for 2011 is 3,834 t for the PRD stock (assuming average recruitment) and 13,777 t for the SOG (assuming good recruitment). The HCR for the minor stock areas assume average recruitment, regardless of forecasted stock biomass, and recommends a 10% harvest rate. Following application of these rules, the recommended maximum available harvest in 2011 for Area 27 is 94t. Future work will consider how to address the uncertainty for Area 2W given no abundance estimate is available.